AMPERE'S LAW

A steady current is flowing parallel to the axis through an infinitely long cylindrical shell of inner radius a and outer radius b. Each group is assigned one of the current densities given below: (In each case, α and k are constants with appropriate units.)

1. $|\vec{J}| = \alpha\, r^3$.
2. $|\vec{J}| = \alpha\, \frac{\sin kr}{r}$.
3. $|\vec{J}| = \alpha\, e^{kr^2}$.
4. $|\vec{J}| = \alpha\, \frac{e^{kr}}{r}$.

For your group's case, answer each of the following questions:

1. Find the total current flowing through the wire.

2. Use Ampere's Law and symmetry arguments to find the magnetic field at each of the three radii below:

   (i) $r_1 > b$

   (ii) $a < r_2 < b$

   (iii) $r_3 < a$

3. What dimensions do α and k have?

4. For $\alpha = 1$, $k = 1$, sketch the magnitude of the magnetic field as a function of r.

by David McIntyre